# Carbon Sequestration Council Requests for Revision of the Class VI Well Construction Guidance

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| vii | **Burst strength** refers to the pressure, when applied normal to the surface, that will cause a mechanical well component to rupture. | | **Burst strength** refers to the internal pressure, when applied normal to the surface, that will cause a mechanical well component to rupture. | This is an addition that would provide further clarification when other revisions are made in the document. |
| viii | **Collapse strength** refers to the pressure which will cause a mechanical well component to collapse. | | **Collapse strength** refers to the external pressure which will cause a mechanical well component to collapse. | This is an addition that would provide further clarification when other revisions are made in the document. |
| viii | **Drilling mud** means a heavy suspension used in drilling an "injection well," introduced down the drill pipe and through the drill bit.. | | **Drilling mud** means a weighted liquid used in drilling operations to provide hydrostatic pressure to offset formation pressures, also cools and lubricates the drill bit and carries cuttings out of the wellbore. | This is a modification that would provide clarification when other revisions are made in the document. |
| viii | **Enhanced Oil or Gas Recovery** (EOR/EGR) typically means, the process of injecting a fluid (e.g., water, brine, or carbon dioxide) into an oil or gas bearing formation to recover residual oil or natural gas. The injected fluid thins (decreases the viscosity) and/or displaces extractable oil and gas, which is then available for recovery. This is also used for | | **Enhanced Oil or Gas Recovery** (EOR/EGR) typically means, the process of injecting a fluid (e.g., water, brine, or carbon dioxide) into an oil or gas bearing formation to recover residual oil or natural gas. The injected fluid typically thins (decreases the viscosity) and/or displaces extractable oil and gas, which is then available for recovery. ~~This is also used~~ | These corrections will avoid erroneous statements in the Guidance. |

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| | secondary or tertiary recovery. | | ~~for secondary or tertiary recovery.~~ | |
| ix | **Packer** means a mechanical device that seals the outside of the tubing to the inside of the long-string casing, isolating an annular space. | | **Packer** means a mechanical device that seals the outside of the tubing to the inside of the ~~long-string~~ casing, isolating an annular space. | This is a necessary revision to correct the definition. The packer could be set in a liner; it will not necessarily be set in the long string casing. |
| ix | **Reaming** refers to widening a borehole using a drilling bit or tool. | Enlarging is the term used in other portions of the Guidance to describe the purpose of reaming. See Guidance at 10. | **Reaming** refers to enlarging a borehole using a drilling bit or tool. | This is a modification that would provide useful clarification when other revisions are made in the document. Enlarging is the term used in other portions of the Guidance to describe the purpose of reaming. |
| ix | **Shoe** refers to a rounded collar that is screwed onto the bottom of the casing. It has a check valve in it to prevent backflow of cement slurry. During installation it guides the casing toward the center of the well bore. During cementing cement flows through the shoe and into the space between the casing and formation. | | **Shoe** refers to a rounded collar that is screwed onto the bottom of the casing. It has a check valve in it to prevent backflow of cement slurry. ~~During installation it guides the casing toward the center of the well bore.~~ During cementing cement flows through the shoe and into the space between the casing and formation. | This is a necessary revision to correct the definition. The shoe does not guide the casing toward the center of the well bore during installation. |
| x | **Underground Source of Drinking Water** means an aquifer or portion of an aquifer that supplies any public water | EPA's Response to Comments[1/] states (at 6): "EPA has used regulatory language when available and appropriate. | **Underground source of drinking water (USDW)** means an aquifer or its portion: (1)(i) Which supplies any | EPA should use and reference the regulatory definition of USDW from 40 CFR §146.3. |

1/ EPA, Underground Injection Control (UIC) Class VI Program: Summary of EPA's Responses to Public Comments Received on the Class VI Well Construction Guidance (May 2012) (EPA's Response to Comments).

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| | system or that contains a sufficient quantity of ground water to supply a public water system, and currently supplies drinking water for human consumption, or that contains fewer than 10,000 mg/L total dissolved solids and is not an exempted aquifer.1 | When EPA used terms not defined in the Class VI Rule, it did so for clarity of discussion and to provide context for these terms within GS well construction activities." | public water system; or<br>(ii) Which contains a sufficient quantity of ground water to supply a public water system; and<br>(A) Currently supplies drinking water for human consumption; or<br>(B) Contains fewer than 10,000 mg/l total dissolved solids; and<br>(2) Which is not an exempted aquifer. | |
| 6 | The surface casing is the largest in diameter. It must extend from the ground surface through the base of the lowermost USDW [40 CFR 146.86(b)(2)]. | EPA's Response to Comments states (at 9): "To address this comment, EPA changed the discussion to read as follows: 'The surface casing is the largest in diameter. It must extend from the ground surface through the base of the lowermost USDW [40 CFR 146.86(b)(2)].'<br><br>"EPA clarifies that a conductor casing, if used, would be larger." | Surface casing is the largest in diameter unless conductor casing has been used to initiate the drilling process. Surface casing must extend from the ground surface through the base of the lowermost USDW [40 CFR 146.86(b)(2)]. | EPA's described clarification regarding conductor casing does not appear in the revised Guidance. Moreover, the proposed change does not address the original comment: "The wording of this statement should be revised to eliminate the reference to " 'largest in diameter' as that could be conductor casing rather than surface casing. In addition, the use of 'the' with surface casing suggests a single string when the regulation allows the use of multiple strings to for the surface casing." See EPA's Response to Comments at 9. |
| 6 | Liners, if used, are well materials and must meet all the requirements that would apply | EPA's Response to Comments states (at 8): "To address this comment, EPA has added a | Liners, if used, are well materials and must meet all the requirements that would apply | This is new language that EPA added into the revised Guidance in response to public comments, and |

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| | to casing. This includes being cemented to the surface, having sufficient structural strength, and compatibility with the fluids with which they are expected to come into contact [40 CFR 146.86(b)(1) and 146.86(b)(4)]. If an owner or operator plans to use a liner, EPA encourages the owner or operator to communicate the need for the liner and to determine appropriate construction techniques and testing required to ensure mechanical integrity of the liner with the UIC Program Director. | discussion of liners to the Guidance." | to casing. This includes ~~being cemented to the surface,~~ having sufficient structural strength, and compatibility with the fluids with which they are expected to come into contact [40 CFR 146.86(b)(1) and 146.86(b)(4)]. If an owner or operator plans to use a liner, EPA encourages the owner or operator to communicate the need for the liner and to determine appropriate construction techniques and testing required to ensure mechanical integrity of the liner with the UIC Program Director. | we support this addition except that the language needs to be revised as shown in this comment. Liners typically will not extend to the surface; therefore, they cannot be cemented to the surface. Thus, this revision is necessary to correct the statement. |
| 7 | It is important to consider, when planning for the cementing of Class VI wells, that carbon dioxide can react with the typical Portland cements commonly used in well construction. | | ~~It is important to consider,~~ When planning for the cementing of Class VI wells, there should be consideration of the potential for ~~that~~ carbon dioxide ~~can~~ to contact and react with the ~~typical Portland~~ cements ~~commonly~~ used in well construction. | The expression of this concern should be placed in proper context by reference to the likelihood of the carbon dioxide stream having any contact with the cement used in well construction. |
| 8 | In addition, periodic maintenance will need to be performed during the life of an injection well. Maintenance through a well workover involves sealing off | | In addition, periodic maintenance will need to be performed during the life of an injection well. Maintenance through a well workover involves sealing off | This language in the Guidance provides an important recognition that there is a life of equipment that may require replacement before the end of the project and that monitoring will inform the |

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| | the well, removing the wellhead and either removing equipment or lowering maintenance tools into the well. These workovers are essential to maintaining a properly functioning well and can include replacing and repairing tubing, packer, valves and sensors, repairing corroded casing, and remedial cementing. | | the well, removing the wellhead and either removing equipment or lowering maintenance tools into the well. These workovers are essential to maintaining a properly functioning well and can include replacing and repairing tubing, packer, valves and sensors, repairing corroded casing, and remedial cementing. | appropriate time to change out or replace a well or its components. This is important because, in circumstances where intervention/replacement is planned, it may be possible to use more cost-effective materials that are suitable for stress incurred over the planned lifespan of that specific equipment (rather than entire project life). |
| 8 | The radius of curvature of the well can limit the length of the instruments/tools that can be used. | | The radius of curvature of the well can limit the length of the instruments/tools that can be used although technical advances have reduced and will continue to reduce the adverse impacts of lateral drilling. | There are technical solutions to this problem now and more will undoubtedly be developed. |
| 8-9 | Owners or operators may also want to consider installing landing nipples above the packer. Landing nipples allow for the installation of temporary safety valves that can be used as temporary replacements for failed down-hole safety valves or can be used to seal off the formation from the well bore during a workover operation (see Figure 5). | | Owners or operators may also want to consider installing landing nipples above the packer. Under some circumstances, landing nipples could allow for the installation of temporary safety valves that can be used as temporary replacements for failed down-hole safety valves or can be used to seal off the formation from the well bore during a workover operation (see Figure | This will not be true in all cases. It depends on the objective of the workover. If landing a nipple is installed above the packer and tubing is pulled, the landing nipple comes out too. |

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| | | | 5). | |
| 11 | The results from the caliper log are used to calculate the amount of cement needed and to identify any potential areas of lost circulation. | | The results from the caliper log are used to calculate the amount of cement needed ~~and to identify any potential areas of lost circulation.~~ | The results from the caliper log are used to calculate the amount of cement needed and are not typically used to determine areas of lost circulation. |
| 14 | EPA understands that a safety factor typically is included in determining the necessary strength of the well materials, and recommends that an appropriate safety factor be agreed upon with the UIC Program Director. | The American Petroleum Institute (API) is a professional trade organization for the oil and gas industry. The API develops recommended standards and practices, including practices related to well construction and operation which are used throughout the industry. These oil and gas well technologies and practices provide a foundation for Class VI well construction technology. In addition, standard practices from Class I injection well construction inform Class VI requirements. Revised Guidance at 1-2. | EPA understands that a safety factor typically is included in the API recommended standards and practices for determining the necessary strength of the well materials and recommends that these be used as appropriate safety factors are agreed upon with the UIC Program Director. | The API recommended standards and practices have been developed over many years of use and experience and provide the most informed estimates of the appropriate safety factors. |
| 19 | EPA expects that the information on the injection depth, temperatures, injection and formation pressures, and loadings will be compared by the UIC Program Director to the materials proposed and the appropriate construction | 146.86 (b) Casing and Cementing of Class VI Wells. (1) Casing and cement or other materials used in the construction of each Class VI well must have sufficient structural strength and be designed for the life of the | EPA expects that the information on the injection depth, temperatures, injection and formation pressures, and loadings will be compared by the UIC Program Director to the materials proposed and the appropriate construction | Casing corrosion requirements and material strength characteristics are stipulated that they should cover stress evolution over the project life. It should be recognized that there is a life of equipment that may require replacement before the end of the |

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| | standards to ensure that the materials proposed to be used in constructing the Class VI injection well can last the life of the project. | geologic sequestration project. All well materials must be compatible with fluids with which the materials may be expected to come into contact and must meet or exceed standards developed for such materials by the American Petroleum Institute, ASTM International, or comparable standards acceptable to the Director. | standards to ensure that the materials proposed to be used in constructing the Class VI injection well will be used and maintained in a manner to ensure that the well can last the life of the project. | project and that monitoring will inform the appropriate time to change out or replace a well or its components. In circumstances where intervention/replacement is planned it may be possible to use more cost-effective materials that are suitable for stress incurred over the planned lifespan of that specific equipment (rather than entire project life). |
| 20 | When cement cannot be recirculated to the surface, as demonstrated through the use of logs, it may be acceptable to use staged cementing to achieve cementing to the surface [40 CFR 146.86(b)(4)]. | Section 146.86(b)(4) states: "Circulation of cement may be accomplished by staging. The Director may approve an alternative method of cementing in cases where the cement cannot be recirculated to the surface, provided the owner or operator can demonstrate by using logs that the cement does not allow fluid movement behind the well bore." | When cement cannot be recirculated to the surface, ~~as demonstrated through the use of logs, it may be acceptable to use staged cementing~~ the Director may approve an alternative method of cementing ~~to achieve cementing to the surface~~ [40 CFR 146.86(b)(4)]. | The current statement in the revised Guidance is incorrect because it does not accurately reflect the flexibility that the rule itself provides. Section 146.86(b)(4) has two distinct provisions. First, it authorizes circulation of cement by staging. Second, it authorizes the Director to approve an alternative method of cementing (which is not expressly limited to staging) "where the cement cannot be recirculated to the surface". This authorization of an alternative method of cementing is limited by the requirement that "the owner or operator can demonstrate by using logs that the cement does not allow fluid movement behind the well |

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| | | | | bore." As reflected in the language of the regulation, the use of logs is to show that the construction will not allow fluid movement, not that cement cannot be recirculated to the surface. |
| 20 | As previously discussed, the surface casing provides stability to the well bore by preventing unconsolidated soils and aggregates from falling into the borehole. | EPA's Response to Comments states (at 9):<br><br>"EPA clarifies that a conductor casing, if used, would be larger." | As previously discussed, the surface casing (or conductor casing if it is used) provides stability to the well bore by preventing unconsolidated soils and aggregates from falling into the borehole. | This is also the function of conductor casing, which is not mentioned anywhere in the revised Guidance. EPA's described clarification regarding conductor casing does not appear in the revised Guidance. The recommended addition will provide that clarification here. |
| 20 | Cementing of the long string casing serves to seal off the well bore and may prevent fluid or injectate leaks through the casing from entering a permeable zone, such as a USDW. | | Cementing of the long string casing serves to seal off the well bore and isolate the various permeable zones within the open hole from each other. This ~~and~~ may prevent fluid or injectate leaks through the casing from entering a permeable zone, such as a USDW: | This is a modification that would provide clarification when other revisions are made in the document. |
| 20 | If the cement was absent or improperly emplaced, and there was a tubing and casing failure, carbon dioxide could enter a permeable zone and then potentially migrate into USDWs through an annulus, | | If the cement was absent or improperly emplaced, and there was a ~~tubing and~~ casing failure, carbon dioxide could enter the point of failure and find its way to a permeable zone and then potentially be transmitted away | This is a modification that would provide clarification when other revisions are made in the document. |

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| | faults, or abandoned wells, which would be a permit violation, and would require cessation of injection [40 CFR 146.88(f)]. Cementing the casing also protects it from exposure to carbonated brine and other corrosive fluids. | | from the targeted injection interval. This would constitute a permit violation and would require cessation of injection until the casing integrity could be restored. ~~.migrate into USDWs through an annulus, faults, or abandoned wells, which would be a permit violation, and would require cessation of injection~~ [40 CFR 146.88(f)]. Cementing the casing also protects it from external exposure to carbonated brine ~~and~~ or other corrosive fluids. | |
| 24 | This technique reduces the bottom hole pressure exerted by the cement column because, instead of the cement traveling all the way down the tubing and then up the exterior of the casing, the cement column only extends from the surface to the bottom of the hole. | | This technique reduces the ~~bottom hole~~ pressure ~~exerted by~~ required to emplace the cement column because, instead of the cement traveling all the way down the tubing and then being forced up the exterior of the casing, the cement column only extends from the surface to the bottom of the hole. | This is a modification that would provide useful clarification if other revisions will be made in the document. |
| 24 | In some cases, fractured and highly porous formations may make circulation to the surface impossible. In these cases, the Class VI Rule allows alternative methods of | | In some cases, fractured and highly porous formations may make circulation to the surface impossible. In these cases, the Class VI Rule allows alternative methods of | The language in the revised Guidance does not accurately state the rule requirement because the rule only says using logs. It does not require "using cement logs that evaluate the cement in a radial |

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| | cementing if approved by the UIC Program Director, provided that the owner or operator can demonstrate by using cement logs that evaluate the cement in a radial direction that the cement does not allow fluid movement behind the well bore (e.g., it will still prevent fluid movement up the annulus between the casing and formation) [40 CFR 146.86(b)(4)]. | | cementing if approved by the UIC Program Director, provided that the owner or operator can demonstrate by using cement logs and technology that evaluates the cement in a radial direction that the cement does not allow fluid movement behind the well bore (e.g., it will still prevent fluid movement up the annulus between the casing and formation) [40 CFR 146.86(b)(4) and (5)]. | direction". The language should be revised as shown and referenced to (b)(5) as well as (b)(4). |
| 30 | If the proposed annular pressure is greater than the collapse pressure of the tubing, the UIC Program Director may either require more competent tubing or allow for a reduction in annular pressure. If a lower annular pressure is allowed, EPA recommends that the owner or operator still maintain a positive pressure on the annulus. | | If the proposed annular pressure is greater than the collapse pressure of the tubing, the UIC Program Director may either require more competent tubing or allow for a reduction in annular pressure. If ~~a lower~~ an annular pressure lower than the injection pressure is allowed, EPA recommends that the owner or operator still maintain a positive pressure on the annulus. | This revision will clarify that the Director may authorize a pressure lower than the injection pressure as necessary while protecting USDWs. See also the comments for page 34 below. It is particularly important to recognize that this authority may be exercised for wells transitioning to Class VI. |
| 33 | This section provides information about the manner in which an owner or operator may demonstrate that an existing well is appropriate for | | This section provides information about the manner in which an owner or operator may demonstrate that an existing well is appropriate for | The Guidance is intended to be descriptive, not prescriptive, especially where the rule does not specify information that must be considered. |

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| | Class VI injection for GS and clarifies the information that a UIC Program Director will review prior to approving a well for repermitting as a Class VI well, while addressing the intent of the requirements at 40 CFR 146.86(b) and 146.87(a). | | Class VI injection for GS and clarifies the information that a UIC Program Director may want to review prior to approving a well for repermitting as a Class VI well, while addressing the intent of the requirements at 40 CFR 146.86(b) and 146.87(a). | |
| 33 | Wells that might be converted to Class VI wells include Class I wells, Class II wells, and Class V experimental technology wells, monitoring wells, and stratigraphic test wells. | | Wells that might be converted to Class VI wells include Class I wells, Class II wells, and Class V experimental technology wells, monitoring wells, ~~and~~ stratigraphic test wells, and production wells. | It is not uncommon over the life of an EOR operation for a production well that has produced recycled $CO_2$ with oil and other formation fluids to later be converted to $CO_2$ injection or vice versa. Given the existing universe of 14,000 or so Class II $CO_2$ injection wells, a significant number of such conversations may be expected. |
| 34 | Specifically, the original well schematics required at 40 CFR 146.82(a)(11), and well construction procedures required at 40 CFR 146.82(a)(12), should be submitted with the permit application, along with additional information, as-built specifications, or explanations that demonstrate to the UIC Program Director that the well was constructed | 146.82(a) (11) Schematics or other appropriate drawings of the surface and subsurface construction details of the well; (12) Injection well construction procedures that meet the requirements of § 146.86; | Specifically, the ~~original~~ well schematics required at 40 CFR 146.82(a)(11), and well construction procedures required at 40 CFR 146.82(a)(12), should be submitted for the well in its current configuration with the permit application, along with additional information~~, as-built specifications,~~ or explanations that demonstrate to the UIC Program Director | For existing wells, there is no reason to submit schematics for anything other than the well as it currently exists. An historical schematic of the proposed configuration for a well that was subsequently altered is of no interest even if still available. |

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| | to allow safe carbon dioxide injection over the life of the project. | | that the well was constructed to allow safe carbon dioxide injection over the life of the project. | |
| 34 | Table – Class VI Requirements:<br>Special Considerations for Repermitting Existing Wells as Class VI Wells:<br>40 CFR 146.86<br>• Demonstrate that cement placement and materials are appropriate for carbon dioxide injection for GS | | Table –<br>• Demonstrate that cement ~~placement~~ in place and materials of construction are appropriate for carbon dioxide injection for GS | The focus should be in the cement in place rather than the forward looking "cement placement". |
| 34 | Table - Class VI Requirements:<br>Special Considerations for Repermitting Existing Wells as Class VI Wells<br><br>40 CFR 146.88 to 40 CFR 146.95: Same as for new wells | | 40 CFR 146.88 to 40 CFR 146.95: Same as for new wells (including the ability of the Director to exercise flexibility and adaptation provisions as appropriate for existing wells) | It should be recognized that requirements such as the 40 CFR 146.88(c) requirement for the inner annulus pressure to be maintained above the tubing injection pressure come with authorizations of flexibility that can be exercised by the UIC program Director when necessary to protect the well and USDWs and that such flexibility would be particularly appropriate to be exercised for existing wells.<br><br>This need for flexibility to modify the requirement is based on the induced high differential pressure |

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| | | | | that creates migration potential along the casing and at the packer. Burst pressure rating with 1.25 safety factor for 7" casing will likely be exceeded by applied pressure for any strings less than 29 lb/ft even at a moderate depth of 7500 ft. Absent modification of the annulus pressure requirement, the requirement itself would effectively eliminate many re-use wells as conversion candidates. Project economics would be directly impacted through any unnecessary disqualification of existing assets. |
| 35 | An owner or operator converting a well must consider whether the **original design of the well** is appropriate for GS. | The Safe Drinking Water Act (SDWA) provisions and EPA regulations cited in this document contain legally-binding requirements. In several chapters this guidance document makes recommendations and offers alternatives that go beyond the minimum requirements indicated by the Class VI Rule. This is done to provide information and recommendations that may be helpful for Class VI Program implementation efforts. Such | An owner or operator converting a well ~~must~~ should consider whether the ~~**original**~~ **current design and construction of the well** are appropriate for GS. | This should not be stated as if it is a regulatory requirement. In addition, the key considerations are the current design and construction rather than "the original design" if that is different in any way from the existing well. |

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| | | recommendations are prefaced by the words “may” or “should” and are to be considered advisory. They are not required elements of the Class VI Rule. Revised Guidance at i. | | |
| 36 | Another unique aspect of the Class VI Rule is an assessment of well material compatibility with the carbon dioxide stream and formation fluids, discussed in Section 2.4.2. | Response to Comments at 4: “EPA has changed the statements on material compatibility to match the rule language.” | Another unique aspect of the Class VI Rule is an assessment of well material compatibility with the carbon dioxide stream and formation fluids, discussed in Section 2.4.2. Specifically, well materials must be compatible with any fluids with which they may be expected to come into contact [40 CFR 146.86(b)(1) and 146.86(c)(1)]. | As EPA has recognized, the key consideration is whether well materials are compatible with any fluids with which they may be expected to come into contact. Not all well materials will be expected to come into contact with the CO2 stream whether or not it is mixed with formation fluid. |
| 36 | Compatibility is necessary to ensure that well materials will retain integrity throughout the life of the Class VI project. | 146.86 (b) Casing and Cementing of Class VI Wells. (1) Casing and cement or other materials used in the construction of each Class VI well must have sufficient structural strength and be designed for the life of the geologic sequestration project. All well materials must be compatible with fluids with which the materials may be expected to come into contact | Compatibility is necessary to ensure that well materials used will allow the well to retain integrity throughout the life of the Class VI project. | Casing corrosion requirements and material strength characteristics are stipulated that they should cover stress evolution over the project life. It should be recognized that there is a life of equipment that may require replacement before the end of the project and that monitoring will inform the appropriate time to change out or replace a well or its components. In circumstances where intervention/replacement is |

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| | | and must meet or exceed standards developed for such materials by the American Petroleum Institute, ASTM International, or comparable standards acceptable to the Director. | | planned it may be possible to use more cost-effective materials that are suitable for stress incurred over the planned lifespan of that specific equipment (rather than entire project life) |
| 36 | Impurities including sulfate, sulfide, and nitrates, should also be examined. Additionally, an analysis of formation fluids in the injection zone for these parameters and pH, as required at 40 CFR 146.82(a)(8) and 146.87(c), will inform a determination of material compatibility. | 40 CFR 146.82(a)(8) Proposed pre-operational formation testing program to obtain an analysis of the chemical and physical characteristics of the injection zone(s) and confining zone(s) and that meets the requirements at § 146.87;<br>40 CFR 146.87(c) The owner or operator must record the fluid temperature, pH, conductivity, reservoir pressure, and static fluid level of the injection zone(s). | Impurities including sulfate, sulfide, and nitrates, should also be examined. Additionally, an analysis of formation fluids in the injection zone for ~~these parameters and~~ pH, conductivity and other parameters as required at 40 CFR 146.82(a)(8) and 146.87(c), will inform a determination of material compatibility. | This correction is necessary to make the statement consistent with the actual regulatory requirements. |
| 37 | Analysis of both the injection stream, pursuant to requirements at 40 CFR 146.87(c), and any formation fluids, submitted pursuant to 40 CFR 146.82(a)(7)(iv), will also be necessary to support an assessment of the adequacy of the well materials for carbon dioxide injection for GS. | 40 CFR 146.87(c) The owner or operator must record the fluid temperature, pH, conductivity, reservoir pressure, and static fluid level of the injection zone(s).<br>40 CFR 146.82(a)(7)(iv) An analysis of the chemical and physical characteristics of the carbon dioxide stream. | Analysis of both the injection stream, pursuant to requirements at 40 CFR 40 CFR 146.82(a)(7)(iv), and any formation fluids, ~~submitted~~ pursuant to 40 CFR 146.87(c), will also be necessary to support an assessment of the adequacy of the well materials for carbon dioxide injection for GS. | This correction is necessary to reverse the rule citations to match the actual requirements. In the current statement in the revised Guidance, the citations are backwards. |

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| 36 | The material specifications should account for not only contact with wet or dry carbon dioxide but also formation fluids, impurities within the carbon dioxide stream, and physical contact between construction materials such as the tubing and packer to prevent galvanic corrosion. | 40 CFR 146.86(b) Casing and Cementing of Class VI Wells. (1) Casing and cement or other materials used in the construction of each Class VI well must have sufficient structural strength and be designed for the life of the geologic sequestration project. All well materials must be compatible with fluids with which the materials may be expected to come into contact and must meet or exceed standards developed for such materials by the American Petroleum Institute, ASTM International, or comparable standards acceptable to the Director. | The material specifications should account for not only contact with wet or dry carbon dioxide but also formation fluids, impurities within the carbon dioxide stream, and expected physical contact between construction materials such as the tubing and packer to prevent galvanic corrosion. | This correction will make the statement consistent with the actual regulatory requirements. |
| 37 | Specifically, wells converting to Class VI may not need to meet the requirement that their long-string casing be cemented to the surface if the owner or operator can demonstrate, to the UIC Program Director's approval, that there is proper zonal isolation. However, in all cases, repermitting is contingent upon a demonstration that the well | | | Requirement for cement coverage of existing wells is relatively balanced by stating that it is not required to have cement circulated completely to surface while qualifying that isolation should be verified.<br><br>We agree with the first paragraph of Section 3.2.3 that provides the option to not have cement to surface in a pre-existing well. This |

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| | meets the requirements at 40 CFR 146.86(a) to prevent the movement of fluids into or between USDWs or into any unauthorized zones. | | | is appropriate and still protects the ideal that the system integrity must be verified. This approach should be applied as well to the other features regarding corrosion and material. |
| 37 | To demonstrate zonal isolation, an owner or operator must demonstrate, at a minimum, that the surface casing has intact cement from the bottom of the lowermost USDW to the surface. | § 146.86 Injection well construction requirements.<br>(a) General. The owner or operator must ensure that all Class VI wells are constructed and completed to:<br>(1) Prevent the movement of fluids into or between USDWs or into any unauthorized zones;<br>(2) Permit the use of appropriate testing devices and workover tools; and<br>(3) Permit continuous monitoring of the annulus space between the injection tubing and long string casing. | To demonstrate zonal isolation, an owner or operator must demonstrate, at a minimum, that the surface casing ~~has intact~~ and cement can prevent the movement of fluids into or between USDWs or into any unauthorized zones ~~from the bottom of the lowermost USDW to the surface.~~ It may be easier to make this demonstration if the surface casing has intact cement from the bottom of the lowermost USDW to the surface. | This correction is necessary to make the statement consistent with the actual regulatory requirements. |
| 37 | Additionally, the long-string casing must be cemented from the production zone into the confining layer. | | Additionally, the owner or operator will need to demonstrate that the long-string casing ~~must be~~ and cement can prevent fluid movement into any unauthorized zones ~~from the production zone into the confining layer~~. It may be easier to make this demonstration where the long- | This correction is necessary to make the statement consistent with the actual regulatory requirements. |

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| | | | string casing is cemented from the production zone into the confining layer. | |
| 38 | If cement is not present or is inadequate in permeable areas, drilling out the well and re-cementing may be necessary; alternatively, an owner or operator may determine that the well is not suitable for conversion. | | If cement is not present or is inadequate in permeable areas, ~~drilling out the well and re-cementing may be necessary; alternatively, an owner or operator may determine~~ a number of remediation techniques are currently available and new ones are being developed. These methods can be identified and considered by the owner or operator for presentation to the Director for approval, implementation and testing before there is any need to determine that the well is not suitable for conversion. | The current statement is too limited in scope and gives no recognition to the broad range of methods available for addressing concerns about cement integrity. There should be recognition that these techniques, which are being advanced constantly, can be identified, considered, and presented to the Director for approval, which would allow permitting of the converted well if the applicable requirements of 146.86(a) are met. |
| 38 | The owner or operator should also demonstrate that all permeable zones have been cemented, and that the surface casing extends below the lowermost USDW and is cemented to the surface. | § 146.86 Injection well construction requirements.<br>(a) General. The owner or operator must ensure that all Class VI wells are constructed and completed to:<br>(1) Prevent the movement of fluids into or between USDWs or into any unauthorized zones;<br>(2) Permit the use of appropriate testing devices and | The owner or operator should also demonstrate that the well is constructed and completed to meet the requirements of 146.86(a). This will be facilitated if all permeable zones have been cemented, and ~~that~~ the surface casing extends below the lowermost USDW and is cemented to the surface. | This correction is necessary to make the statement consistent with the actual regulatory requirements. |

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| | | workover tools; and<br>(3) Permit continuous monitoring of the annulus space between the injection tubing and long string casing. | | |
| 38 | A cement bond log evaluating the cement radially may help identify any potential channels in the existing cement, while tracer logs, temperature logs, and noise logs should be used to supplement information collected through the cement bond log. | | A cement bond log evaluating the cement radially may help identify any potential channels in the existing cement, while tracer logs, temperature logs, and noise logs ~~should~~ can be used to supplement information collected through the cement bond log. | More accurate reflection of the requirements. |
| 40 | This can be accomplished by modeling pressures and showing that the fracture pressure of the confining zone is never exceeded. | | This can be accomplished by modeling pressures and showing that the fracture pressure of the confining zone ~~is never~~ will not be exceeded. | This is a modification that would provide clarification when other revisions are made in the document. |
| 40 | The API Guidance Document RF1 – Hydraulic Fracturing Operations – Well Construction and Integrity Guidelines also contains information on ways to perform stimulation without fracturing the confining layer. | | The API Guidance Document HF1 – Hydraulic Fracturing Operations – Well Construction and Integrity Guidelines also contains information on ways to perform stimulation without fracturing the confining layer. | This is a correction of a typographical error that should be made when other revisions are made in the document. |
| 41 | If the owner or operator is concerned that an annular pressure higher than the injection pressure will damage the well or endanger USDWs, EPA recommends that they | | If the owner or operator is concerned that an annular pressure higher than the injection pressure will damage the well or endanger USDWs, EPA recommends that they | This is a modification that would provide clarification when other revisions are made in the document. |

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| | consult with the UIC Program Director to find an applicable solution that will both safeguard USDWs and protect the well. Options may include a more competent casing or **operating at a lower**, but still positive, annular pressure. | | consult with the UIC Program Director to find an ~~applicable~~ acceptable solution that will both safeguard USDWs and protect the well. Options may include a more competent casing or **operating at a lower**, but still positive, annular pressure. | |
| 42 | All components of Class VI wells must be constructed to withstand the stressors of the down-hole environment and be compatible with the carbon dioxide stream and any other fluids with which they might come into contact. | | All components of Class VI wells must be constructed to withstand the stresses of the down-hole environment and be compatible with the carbon dioxide stream and any other fluids with which they might come into contact. | This is a correction in spelling that should be made when other revisions are made in the document. |